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Attention: Dr. T.L.K. Smull, Director

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This is the 9th quarterly progress report on contract No. NASr-54(03), covering the period February 1, 1965 to April 30, 1965.

The project effort during this quarter was divided among the following 5 tasks.

1. Data analysis.
2. Final preparations for a balloon flight carried out on March 10, 1965.
3. Analytical study of atmospheric radiation processes.
4. Development of an infrared interferometer for spacecraft use.
5. Report writing.

The interferometer development, the March 10th balloon flight, and data analysis were of primary concern during this quarter. Details of the progress on each of the 5 tasks are given below.

1. Data Analysis

Work continued on the IBM 7090 computer program for processing the digitized MRIR data from the 26 June 1963 balloon flight.

The technique of sampling, digitizing and tabulating portions of the balloon flight data during flight was developed, tested on an environmental test at Chrysler Missile Division on 19 February 1965 and applied on the 10 March 1965 balloon flight.

The processing of data obtained on the 10 March 1965 balloon flight was about 75 percent complete as of the end of April. Results were obtained as follows.

- a. A complete set of analog Brush recordings of the seven channels of SIRS data was made for the U.S. Weather Bureau.
- b. The SIRS data for the time interval 0857 to 1611 EST was digitized at the rate of 5 samples per second. A tabulation of this digitized data and a listing in IBM 7090 compatible format on magnetic tape were supplied to U.S. Weather Bureau personnel.
- c. A complete set of analog Brush recordings of the J.P.L. spectrometer data were made for J.P.L. personnel.
- d. The J.P.L. spectrometer data were digitized on punched paper tape for J.P.L. personnel.
- e. A complete set of analog Brush records of the MRIR data were made. Some of this data was turned over to NASA Goddard Space Flight Center personnel for their evaluation.
- f. All of the housekeeping data was processed, some in digital form, some in analog form.
- g. The balloon altitude vs. time data, azimuth vs. time data (from photo-cell data) and detailed trajectory data (from aerial photographs) were plotted in graph and map form.
- h. All of the camera photography was processed and contact prints were made.

The only remaining task of data processing for the 10 March 1965 balloon flight was that of digitizing and applying calibration data to the MRIR data. This task had been started at the end of this work period.

2. Final Preparations for 10 March 1965 Balloon Flight

The construction and testing of equipment for the balloon flight was completed early in February. The operational amplifier unit used for signal conditioning was completed. Modifications of the balloon gondola control unit were completed. Foam insulation panels were cut and fitted to the balloon gondola.

A small balloon flight package consisting of a transmitter, a modified AN/AMT-2B radiosonde unit, one channel of FM/FM telemetry, antenna and power supply was constructed for use on a preliminary balloon flight to test the telemetry ground stations (The University of Michigan mobile unit and a down range ground station supplied and operated by U.S. Weather Bureau personnel).

The MRIR (flight model 4) supplied for this balloon flight was calibrated. Calibrations agreed with calibration data supplied by the Santa Barbara Corporation.

Operational testing of the radiation instruments began on 5 February with the interphase tests of the SIRS instrument. An operational test with both SIRS and the MRIR was made on 12 February. Later that day a test with the MRIR and J.P.L. spectrometer was carried out. Finally a complete integration test with all instruments was carried out on 16 February. Results were good with the exception that switching transients interfered with the operation of the J.P.L. spectrometer.

In other tests the operation of the door to the MRIR compartment was found to be unreliable. This fault was corrected by replacing an electrical relay.

An environmental test was held at Chrysler Missile Division on 18 and 19 February. The MRIR radiometer and the SIRS spectrometer operated satisfactorily throughout the tests, however the J.P.L. spectrometer Pb Se detector did not give correct signals, probably because of transient or R.F. interference. In addition there was a malfunction of a solenoid in the J.P.L. liquid nitrogen transfer system during the simulated descent of the balloon gondola. This solenoid should have terminated liquid nitrogen flow at high pressures (low altitudes) but, in failing, permitted a high rate of flow of liquid nitrogen, rupturing the silastic tubing. The resulting escape of liquid nitrogen into a pre-amplifier and the detector itself caused a rupture of the Dewar flask on which the detector was mounted. Finally because the instrument was very cold when high pressure was reached, moisture condensed out onto the instrument.

Since it was desired to obtain radiation measurements while there still was a "winter" atmosphere, it was decided to proceed with the trip to Sioux Falls for the balloon flight, with the hope that the J.P.L. spectrometer could be repaired and partially recalibrated before the balloon flight actually took place.

The first contingent of personnel left for Sioux Falls on February 24. After some delay because of bad weather, and after one launch failure due to high winds, the small payload used to test the telemetry ground stations was launched on Sunday, 5 March.

J.P.L. personnel arrived on March 7, and although tests showed that gondola switching transients still interfered with the operation of the J.P.L. spectrometer, it was decided that to avoid further delay the instrument should be flown in that condition.

The balloon flight took place on 10 March 1965 with launch at 0710 EST. The rate of rise was about 511 ft/min until the balloon reached 52,000 feet and about 833 ft/min from 52,000 to 106,400 feet. Float altitude was 107,000 feet decreasing to 105,000 feet later in the day. When the balloon arrived at float altitude it was about 6 miles southeast of Primghar, Iowa. It floated in a southwest direction for the rest of the flight and was about 7 miles south of Stanton, Nebraska, when it was cut down at 1636 EST. During descent it floated south and east and landed at Snyder, Nebraska, at about 1710 EST.

The flight was over clear skies with partially snow covered ground for most of the day. The sky beneath the balloon was partially cloudy between 1110 EST and 1202 EST and from 1446 EST to cutdown at 1636 EST.

The NIMBUS MRIR received excellent data throughout the flight. To the great surprise of all, the J.P.L. spectrometer transient interference disappeared after the balloon launch with excellent operation from this point on to the end of the flight.

The SIRS instrument data does not appear to be satisfactory, due to some kind of interference super-imposed upon the signals. U.S. Weather Bureau personnel believe this to be R.F. interference from the 1.7 megacycle beacon used for balloon altitude telemetry and for tracking the balloon by radio-direction finding techniques.

Auxiliary equipment including cameras and photocells for sun azimuth data worked properly. The two thermistors used for free air temperature measurement show wild fluctuations which can be correlated with illumination by the sun and which, therefore are probably due to the absorption of solar radiation by the thermistors. A technical report, presenting engineering data on the balloon flight, will be prepared in the near future.

3. Analytical Study of Atmospheric Radiation Processes

Comparison of calculated transmissivities for homogeneous paths with laboratory measurements showed most disagreement at low pressures.

Possible causes of this disagreement may be:

- a. Band strengths used for the calculations may be too low.
- b. The commonly accepted half-width (0.064 cm^{-1} at 1 atmosphere and 298° K) also may be too low a value.

Both of these possible sources of error are being investigated.

The new, more accurate and flexible computer program for the calculation of transmissivities by direct integration has progressed to the stage where decisions are being made regarding the type of quadrature to be used so that good accuracy and acceptable speed can be obtained.

A paper on some of this work was presented at the Conference on Atmospheric Limitations to Optical Propagation in Boulder, Colorado, on March 18-19, 1965 (see Section 5).

4. Development of an Infrared Interferometer for Spacecraft Use

Development of an Infrared Interferometer continues, with the effort being about equally divided between electronic, optical, and data processing problems.

Integration of the electronics supplied to us by NASA Goddard Space Flight Center personnel has continued. The work with this breadboard electronics unit consists of impedance matching, eliminating or reducing noise, adjusting signal levels and just coming to a good understanding, in engineering detail, of how the electronics package actually works. Recording devices have been provided and finally several rather satisfactory sets of interferograms have been made. This includes infrared interferograms with the "divide by ten" circuit in operation as well as the visible (neon light) monochromatic signal. Signal to noise ratios of about 250 to one were obtained.

The neon lamp NE-2P and its filters were tested on the Perkin-Elmer 13-U spectrometer. Most of the prominent lines of neon were identified. A short note describing the use of the NE-2P as a convenient spectral source was prepared.

The problem of non-uniform drive motion which has been of considerable concern appears to have been solved by the use of hardened and ground steel faces for the spring clamps.

The gold cones to be used for detector optics were received and field of view measurements of the KBr lens and gold cone were made. Measured values match design values very closely.

A test was made for voltage breakdown between the bolometer and gold cone, and the proper use of insulation to eliminate this voltage breakdown has been determined.

The technique of using conductive cement to repair broken electrical connections has been mastered. Two Barnes bolometers with broken flake connections were repaired with this technique.

A set of KBr plates were cemented with Pliobond cement. The beam splitter thus assembled worked quite satisfactorily.

Errors in computer programs used in calculating spectra from interferograms have been corrected. Many test interferograms have been processed. Finally several interferograms obtained with the scientific breadboard were processed into spectra.

Other work was completed as follows. The first engineering breadboard was completed and delivered to Goddard Space Flight Center on 29 March. The second engineering breadboard was completed and was operating at the end of April. A third internal magnet mirror drive unit was completed and tested at Goddard Space Flight Center on 26 April.

All of the electronic diagrams supplied with the Goddard electronics have been redrawn. The design of a framework for use in packaging the electronics was started.

5. Report Writing

A paper "Problems Involved in Calculating Atmospheric Slant Path Transmission in the 15 Micron CO₂ Band," by S. Roland Drayson was presented at the Conference on Atmospheric Limitations to Optical Propagation held at the Central Radio Propagation Laboratory and NCAR at Boulder on 18-19 March, 1965.

A short newsletter describing the aircraft flight tests of the flight tests of the HRIR was prepared by G. Liepins and sent to NCAR for publication in their Scientific Aviation Newsletter.

6. Summary of Future Work

The following tasks will receive major attention during the next quarter.

- a. Development of the Infrared Interferometer.
- b. Analysis of data.
- c. Post flight calibration of the NIMBUS MRIR unit F-4.
- d. Analytical study of atmospheric radiation processes.
- e. Report writing.